CHARCOAL ROT

Soybean Diseases

Overview

Charcoal Rot of soybean is caused by the soilborne fungus *Macrophomina phaseolina*. While historically considered a southern problem, its importance is increasing in the North Central States and Ontario, Canada. For instance, it is the most important soybean disease in Kansas. Increases in the disease's importance parallel increases in average summer temperatures and the increasing number of extended dry periods that are occurring in July and August, when most soybeans are in the reproductive stages of growth.

The fungus causes a general root rot in soybean, infecting the roots and lower stems. The name *charcoal rot* is descriptive of the small, black, fungal structures, known as microsclerotia, that form in and on the lower stem and roots of infected plants. Yield loss from charcoal rot is highly variable based on when conditions favorable for disease develop. The earlier hot and dry conditions appear, the greater the yield loss will be. Fields under drought stress without charcoal rot will often survive and extra two or more weeks compared to those with *M. phaseolina* present. Yield losses from this earlier plant death can then be directly attributed to the disease. Management generally involves various ways to maintain adequate soil moisture when rainfall is limited.

Scouting

See *Charcoal Rot*, *Crop Protection Network* Bulletin CPN-1004 for a complete discussion and diagnostic photos of charcoal rot and other soybean diseases with similar symptoms.

Infection of the plant occurs early in the season when soil moisture levels are high. However, symptoms typically do not develop until the reproductive stages when plant moisture requirements increase, and soil moisture becomes limiting. If excessively dry soil conditions do not occur, then late season symptoms will not develop.

Symptoms of Charcoal Rot

- Charcoal rot usually develops in the driest areas of the field first. These would include field entryways and headlands where equipment traffic can increase soil compaction, sandy areas, terrace tops, and along tree lines. Infected plants wilt in the midday heat, recovering at night, until eventually the permanent wilt point is reached.
- The first symptoms of charcoal rot are often a brown streaking in the taproot or secondary roots. At this point, the microsclerotia have not yet begun to develop.
- Infected plants may have premature yellowing of the top leaves and premature leaf drop. This is easy to mistake for normal maturity. Look for unfilled upper pods and generally lower plant vigor. In some cases, the upper one-third of the plant may have only flat pods without seed.
- If hot, dry weather continues during the R5 to R6 growth stages, a light gray discoloration often develops on both the outer and inner stem tissues and on the taproot and secondary roots. Scrape the outer tissues and use a hand lens to look for the presence of the black microsclerotia – a diagnostic symptom of charcoal rot.
- On mature plants, the microsclerotia are easily seen embedded in grayish areas on the outer stem tissue, often without the need of a hand lens.
- A symptom known as zone lines are often observed in the lower stem and roots of soybeans when they are split lengthwise. Lines are thin and dark, appearing in irregular patterns and small circular shapes. For a long time, it was assumed that these were associated with charcoal rot. However, it has now been demonstrated that these zone lines are associated with other stem diseases such as Phomopsis seed decay, pod and stem blight, and stem canker.

In some cases, charcoal rot symptoms may appear in lower wetter areas of the field. In these instances, the soybeans have previously been infected with other root rotting diseases including Pythium, Phytophthora or Rhizoctonia root rot. The damaged root system decreases the ability of the roots to move water from the soil to the plant, putting the plant under moisture stress. Microsclerotia then begin to form on these moisture stressed plants. In these situations, the charcoal rot fungus can be considered a secondary invader.

Management

Stress caused by high plant populations, soil compaction, improperly applied herbicides, nematodes, or other diseases can favor the charcoal rot pathogen and increase the risk of infection. Unlike most soil fungi, which decline in activity when soils become too warm, the charcoal rot fungus is most active when soil temperatures are high (> 85° F)

Management is best achieved by a combination of practices.

- Plant the fullest-season varieties that are practical for your area. For instance, maturity group 5 soybeans as a group will be more tolerant to charcoal rot than maturity group 3 soybeans. Plants are most susceptible to charcoal rot beginning at flowering. The longer-season varieties tend to flower later and are still in vegetative growth stages during the hottest, driest portion of the growing season. Pushing flowering back until later in the season when soil temperatures are decreasing, and rainfall often increases, will help avoid serious losses. This is less practical in northern areas where frost may become an issue on later planted soybeans.
- Use no-till or strip-till systems to increase soil microbial activity and conserve soil moisture, which can reduce charcoal rot incidence. Soybeans direct-seeded in no-till systems typically have lower levels of charcoal rot compared to soybeans under conventional tillage.
- Use of narrow rows, which results in earlier canopy closure, can help reduce disease losses by reducing soil moisture evaporation.
- Rotate to non-host crops for one to two years in fields with a history of charcoal rot. Wheat and other small grains are good rotational choices. Although corn, grain sorghum, sunflowers, and other crops are hosts, research has shown that charcoal rot strains have host preferences. For instance, some strains prefer soybeans, while others prefer corn or sunflowers. Therefore, rotation with any other crop can be beneficial and the longer the rotation, the better.
- Avoid excessive seeding rates. Seeding rates of 100,000 seeds per acre can significantly reduce charcoal rot losses in problem fields by making more moisture available on a per plant basis in times of drought stress. If timely rains do occur, the plants will compensate for the lower plant numbers by increasing branching.
- Supplemental irrigation, if available, is probably the best way to manage the disease.

No fungicide seed treatments have been identified that offer consistent control of charcoal rot and foliar fungicides are not effective.

Distribution

Charcoal Rot, *Crop Protection Network*, 2015, CPN-1004

Soybean Research Information Network, Charcoal Rot in the North Central Region (video series)

Identification and Management of Charcoal Rot of Soybeans (Webcast), *Plant Management Network – Focus on Soybeans*, 2013

Scouting for Soybean Stem Diseases, *Crop Protection Network* CPN 1002, 2015

Stem Zone Lines: Fact or Fiction, *Crop Protection Network* CPN 1015, 2016

Resources

Charcoal Rot
Crop Protection Network, 2015
https://cropprotectionnetwork.org/publications/an-overview-of-charcoal-rot-of-soybean

Advancing Our Understanding of Charcoal Rot in Soybeans
Journal of Integrated Pest Management, 2017
https://academic.oup.com/jipm/article/8/1/8/3064076

Charcoal Rot in the North Central Region: a series of videos on charcoal rot research, field identification, and management of this emerging disease.
Soybean Research Information Initiative
https://www.youtube.com/channel/UC1EL0JQW26cP1WsCdW8mpXQ

Scouting for Soybean Stem Diseases
Crop Protection Network CPN 1002, 2015
https://soybeanresearchinfo.com/wp-content/uploads/2019/03/CPN1002_ScoutingSoybeanStemDiseases051515.pdf

Seasonal Progress of Charcoal Rot and Its Impact on Soybean Productivity
Plant Disease, 2011
https://soybeanresearchinfo.com/wp-content/uploads/2019/03/pdis-02-11-0100.pdf

Soybean Stem Zone Lines - Zone lines are a symptom of diseases caused by Diaporthe species of fungi
Crop Protection Network CPN 1015, 2016
https://cropprotectionnetwork.org/publications/soybean-stem-zone-lines-fact-and-fiction

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This website is funded by the soybean checkoff

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